1. INTRODUCTION OF PRINCIPAL STRESSES, ROCK MASS PROPERTIES AND EXCAVATION SEQUENCE ADOPTED IN THE MODEL

The principal stresses are used while modeling the desander basins of the Upper Trishuli 1 Hydroelectric Project (216 MW) in Phase2 after carrying out the transformation of principal stresses obtained from the hydraulic fracture test conducted at the ventilation tunnel of the powerhouse as shown in Table 1. Parallel excavation of all three desander basins is carried out in the model. The rock supports adopted in the model for class IV are mentioned below. The excavation sequence within the desander basin is based on the method of statement of desander basin as shown in Figure 1.

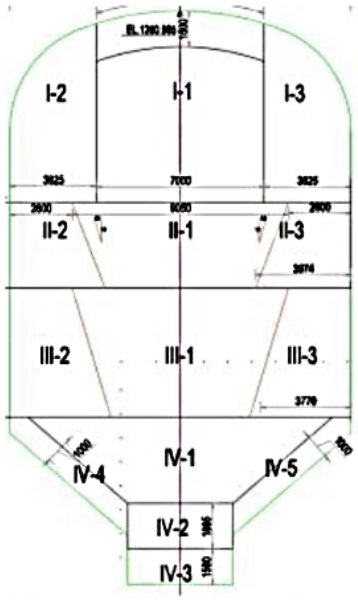


Figure 1: Excavation sequence of the desander basin used in the model.

Table 1: The principal field stress adopted in the model of desander basin.

SN	Principal Stress	Magnitude (MPa)	Azimuth
1	σ_1	6.01	Kept as Vertical stress in model
2	σ_3	5.44	Horizontal stress
3	σ_z	5.97	Out of plane

Table 2: Mechanical parameters of rock mass, intact rock of desander basin adopted in the model.

Rock Class	Q	GSI	Intact rock UCS (MPa)	Ei,Youngs modulus of rock mass (GPa)	Poisson's Ratio	mi
Class IV	1.3	41	60	2.3	0.3	10

Table 3: Rock supports adopted in the model.

Class IV				
Thickness of shotcrete (mm)		Compressive Strength (MPa)	Properties of rock dowels	
Crown	Walls		Crown	Wall
100 first layer + **ISMB 150 at 1 m spacing**+ layer+ 80 mm second layer	100 first layer+ 80 mm second layer	30	6 m length, 32 mm dia. @ 1.5 x 1 m spacing	9 m length, 32 mm dia. @ 1.5 x 1 m spacing

2. RESULTS OF THE MODELLING

The results of the modeling with the assumed rock mass properties and rock supports are given below.

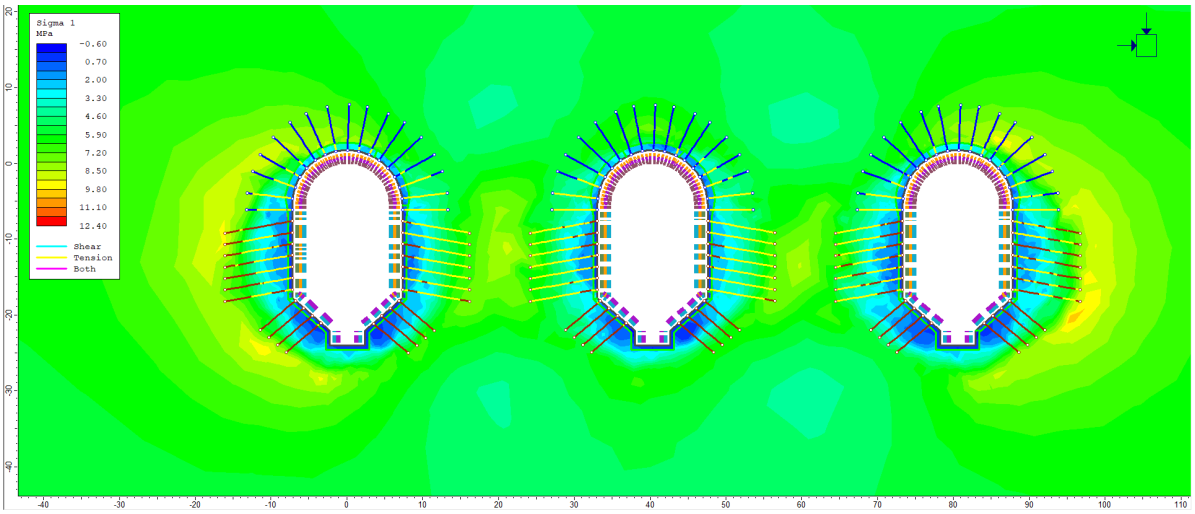


Figure 2: Rock dowels in-between the desander basins mostly exceeded the allowable tensile strength of the dowels after the full excavation.

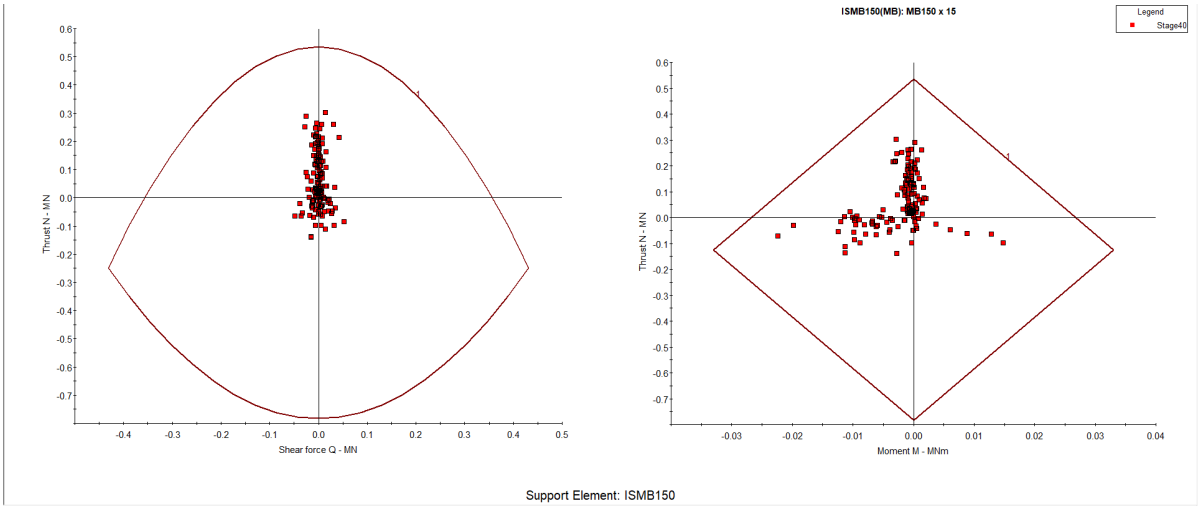


Figure 3: Capacity envelope of ISMB 150 on the crown of the desander basins.

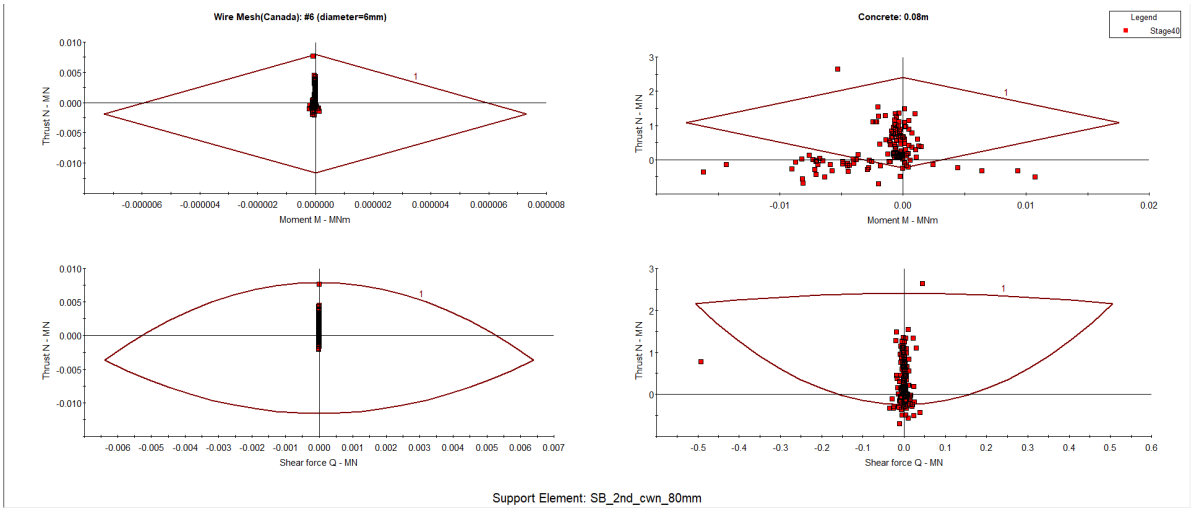


Figure 4: Capacity envelopes of second layer shotcrete (80 mm) on the crown.

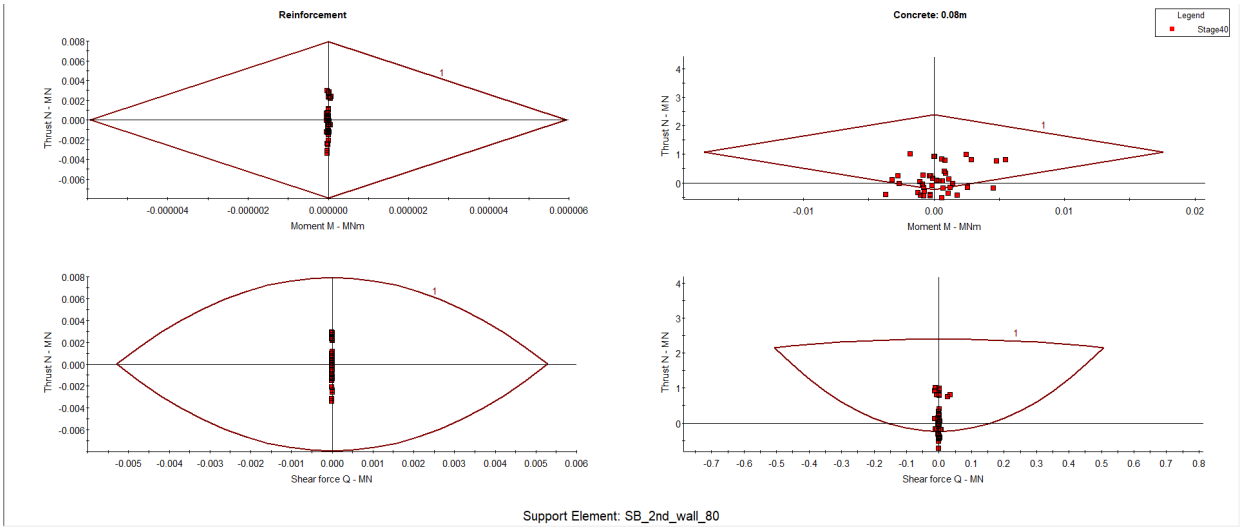


Figure 5: Capacity envelopes of second layer shotcrete (80 mm) on the walls.

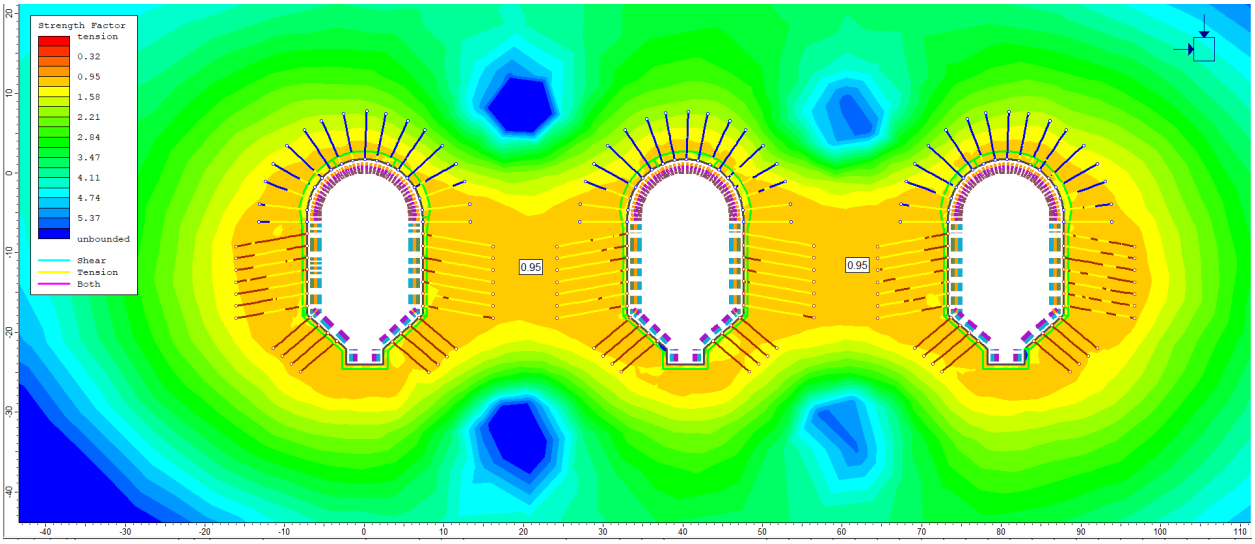


Figure 6: Strength factor distributions around the desander basin after the full excavations.

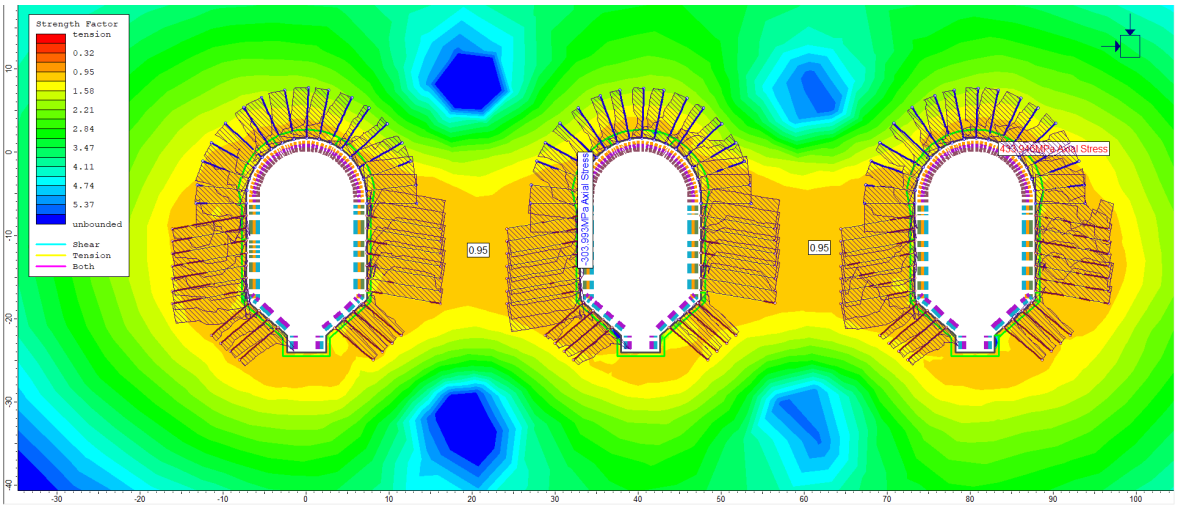


Figure 7: Axial stress distribution of all the dowels around the desander basins.

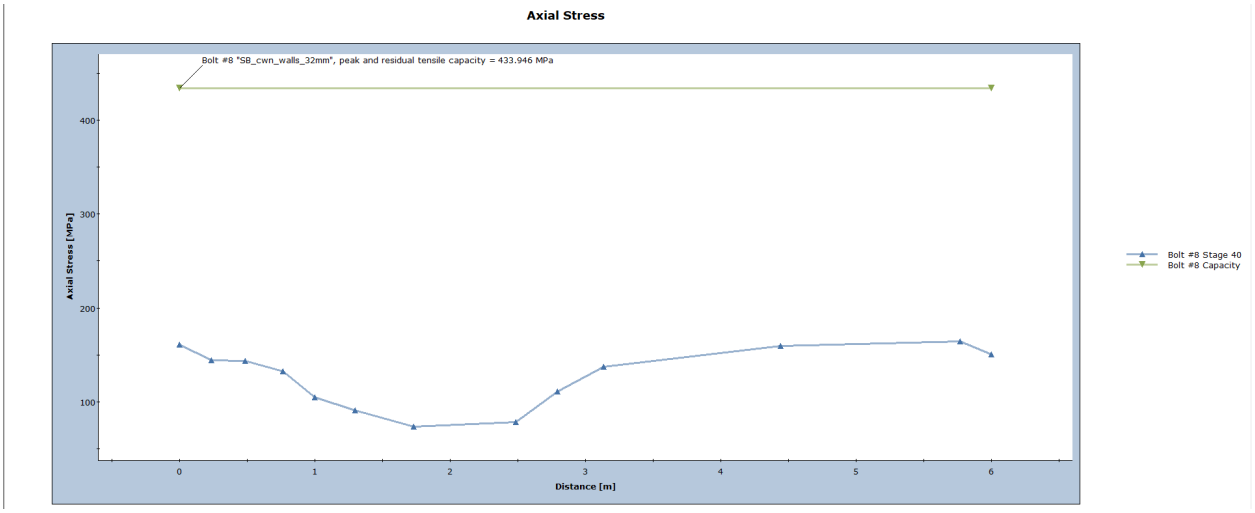

Axial Stress
Bolt #8 "SB_cwn_walls_32mm", peak and residual tensile capacity = 433.946 MPa
Axial Stress [MPa]
Distance [m]
Bolt #8 Stage 40
Bolt #8 Capacity

Figure 8: Axial stress distribution of rock dowel on the crown.

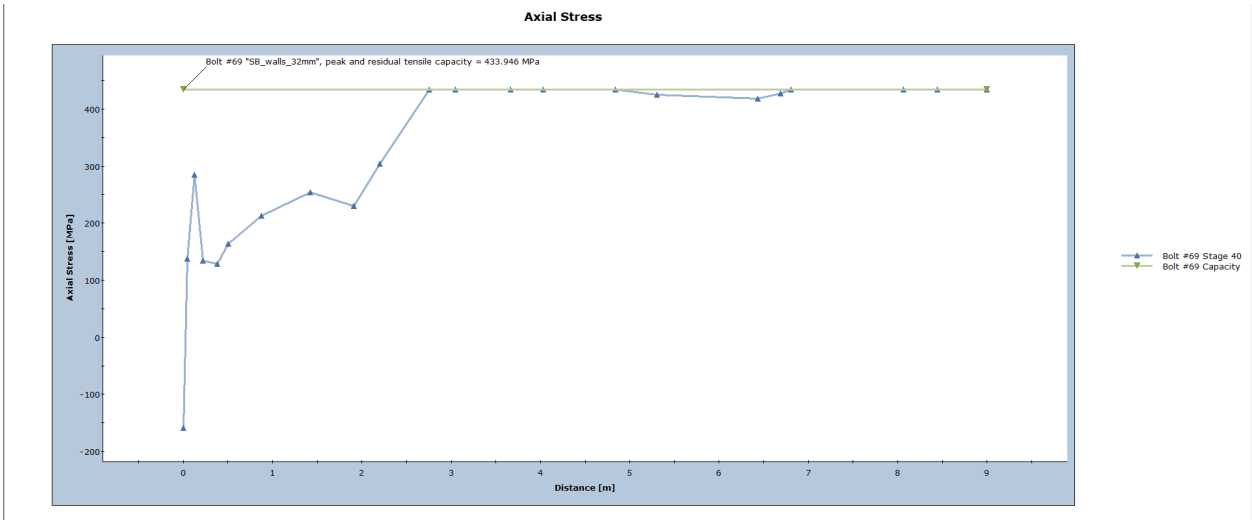

Axial Stress
Bolt #69 "SB_walls_32mm", peak and residual tensile capacity = 433.946 MPa
Axial Stress [MPa]
Distance [m]
Bolt #69 Stage 40
Bolt #69 Capacity

Figure 9: Axial stress distribution of rock dowel on left wall of desander basin 2 (middle one).

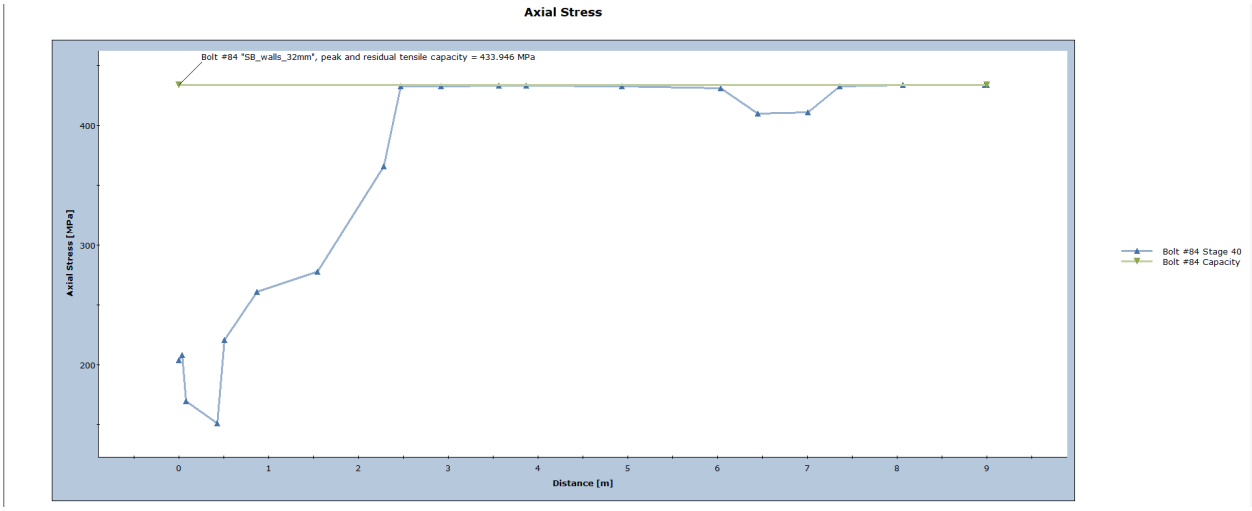

Axial Stress
Bolt #84 "SB_walls_32mm", peak and residual tensile capacity = 433.946 MPa
Axial Stress [MPa]
Distance [m]
Bolt #84 Stage 40
Bolt #84 Capacity

Figure 10: Axial stress distribution of rock dowel on right wall of desander basin 2 (middle one).

3. CONCLUSIONS AND RECOMMENDATIONS

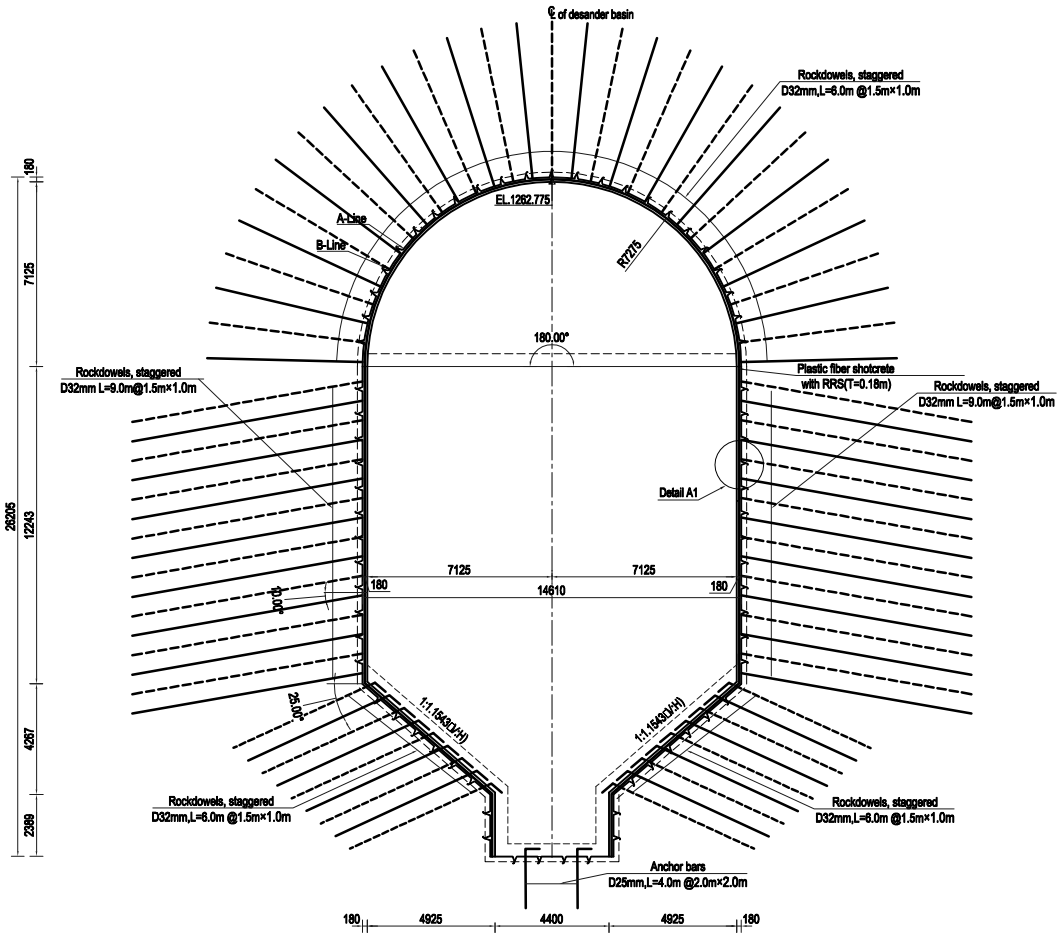
Based on the rock mass properties assumed in the model for class IV, the modelling of the desander basins is carried out. The following conclusions are made from the results of the modelling including the recommendations.

- The sectional spacing of the adopted rock dowels should be 1.5 m whereas the longitudinal spacing should be 1 m on the crown and on the walls of the Desander basin, for 6 m long rock dowels on the crown and 9 m long rock dowels on the walls, and the shotcrete thickness is 180mm.
- ISMB150 ribs should be installed on the crown at the spacing of 1 m. In the modelling, it helped to minimize the failure of second layer shotcrete linings that failed significantly without the ribs alternatively RRS shall also be applied instead of steel ribs.
- Consolidation grouting should be carried out in-between the Desander basins Pillar if all three bays consist of Rock Support Class IV, as the strength factor is found to be less than 1, i.e., 0.95. This will help to relieve the overstressed rock dowels on the walls and minimize shotcrete failure.

- The axial stress on the rock dowels of the walls have exceeded the allowable tensile strength of the dowels mainly in-between the Desander basins. However, most of the axial stresses on the dowels of the crown are on the lower range.
- For the finished section of pilot tunnel, since the support has been done, the additional support is required and it must be installed before the enlarge excavation starts.

Typical section (Class IV)

1:100



NOTE

1. All dimensions are in millimeters, and coordinates, chainages & elevations are in meters.
2. For Detail 1, Please see UT1-C-000-CVL-DG-40001.

Legend:

Excavation line

Scale:

1:100 0 1 2 3 4 5m

REFERENCE DRAWINGS

UT1-C-000-CVL-DG-40001	Detail Design Drawing of Excavation and Support for Underground Cavern
UT1-C-030-CVL-DG-52001	Layout drawing of desander basin
UT1-C-030-CVL-DG-53002	Excavation and support drawing of flushing tunnel
UT1-C-150-CVL-DG-54002	Excavation and support drawing of headrace tunnel
UT1-C-030-CVL-DG-51004	Excavation and support drawing of U/S access tunnel
UT1-C-030-CVL-DG-51002	Excavation and support drawing of D/S access tunnel

SYMBOL AND LEGEND

FOR ATTACHMENT

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REV. NO.	DATE	DESCRIPTION	DRAWN	CHKD.	APPD.
OE	22.JUN, 2023	RN-0667	PRAKRITI PANTA	ZHANG J.Q.	LI W.G.
OD	10.May, 2023	RN-0474	PRAKRITI PANTA	ZHANG J.Q.	LI W.G.
OC	04.FEB, 2023	RN-0289	GUO YAO	ZHANG J.Q.	LI W.G.
OB	02.SEP, 2022	RN-0119	GUO YAO	ZHANG J.Q.	LI W.G.
OA	26.APR, 2022	FIRST ISSUE	WANG H.Q.	ZHANG J.Q.	LI W.G.

PROJECT TITLE

Upper Trishuli-1 HEP (216MW)

OWNER

NWEDC

OWNER'S ENGINEER

TRACTEBEL ENGIE jade CONSULT

CONTRACTOR

DOOSAN Enerbility

DRAWING TITLE

EXCAVATION AND SUPPORT DRAWING OF DESANDER BASIN (TYPICAL SECTION FOR CLASS IV)

INDEX	DRAWING NUMBER	SHEET NO.	REV. NO.
A			

A1 (594 x 841 MM)